

In summary, the position after 100 years of interdisciplinary courses in applied science is that:

- the boundaries between the disciplines are as apparent as they were in the early courses;
- the boundaries are most evident in the service course, where the students go to different people in different places for parts of the course and there is often little evidence of meaningful dialogue between the different teachers;
- the sequence of presenting the disciplines is debatable but it has not changed substantially;
- as a consequence of the expansion of knowledge the engineering discipline was nearly lost from the curriculum, but the danger has probably passed;
- of the concomitant disciplines, there is no clearly apparent reason why the physical sciences should always precede the engineering discipline whereas the social sciences should always follow it.

The fact that these features of the courses have been retained for so long is not only evidence of no great change but also of no obvious need to change. Good students have been attracted to and stayed with the courses, and as graduates they have been well-accepted by the community, more so than some others. This example of development in an interdisciplinary course is, therefore, not a bad one to emulate, although some modifications may still be desirable to meet the expectations of different people under different circumstances.

#### SLIPPERY BOUNDARIES OF LIPID RESEARCH

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POLITICAL, economic and academic planning are seldom necessary to bring about the birth of fruitful ideas, but the development of projects to an applied or applicable stage requires funds, services and opportunities to arouse interest among students. Those who can guarantee support are not necessarily able or willing to tolerate novelty. Practical considerations rather than professional broadmindedness permit a breakthrough here and there, but interest in interdisciplinary research is often stigmatised as "amateurish" and the most important branches of knowledge are often handicapped by neglect.

As an example, lipid research is not entirely ignored but is

literally vital importance to man is poorly recognised or misused. To justify this statement the theoretical and practical significance of lipids will be summarised; then we shall consider some streams of lipid research and comment on the training and prospects of future workers in this field.

Lipids are in common parlance fats and oils, particularly those of natural origin, e.g., butter, olive oil, the fats distributed through meat or circulating with blood, constituents of egg yolk that may be extracted with appropriate solvents, etc., etc. Given suitable conditions, including eons of time, similar lipids turn into petroleum, the study of which seldom attracts the typical lipid chemist.

The economic importance of animal and vegetable oils and fats is beyond argument. Apart from dietary purposes many are sold for industrial conversion into soap, other detergents and starting materials for explosives (e.g., dynamite), cosmetic preparations, plastics and remedies. Large industrial concerns that process fats and oils are major employers of chemists with tertiary or sub-tertiary training. Of these Unilever deserves to be mentioned for its excellent illustrated educational booklets that introduce students to data, problems and methods of pure and applied lipid chemistry.

In comparison with this teaching effort of an admittedly not uninterested party, academic curricula (except in departments specialising in food or industrial chemistry) tend to ignore the chemistry of lipids except, perhaps, for less than one per cent of the teaching effort devoted to some technical methods of analysis. These remain remarkably useful after a century or so but are dull to learn or practise. Predictably technologists of the future will make more or possibly exclusive use of modern instrumental methods which are intellectually more stimulating.

If the importance of lipids were purely industrial it would be reasonable enough to leave problems of special training to concerns interested in acquiring skilled staff. However, lipids play a variety of star roles in the functioning of biological systems. Dietary lipids store and dispense energy, part of their molecules can be incorporated into sugars and proteins; they are used to store water and to provide physical effects such as lubrication and thermal insulation; part of the lipids ingested turns into dispersing agents that bring about the absorption of unchanged lipids from the intestine. Chemical elaboration by the living organism converts the more common lipids into traces of vitamins and hormones that regulate our health and much of our psychology. Next to water, the most important constituents of the brain are lipids which must be

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thoroughly understood before we can acquire confident mastery of nerve physiology and psychiatry in a material sense.

It should be clear that lipids form an especially important domain of chemical species. With fewer data to confuse one, this has been recognised at the time modern organic chemistry was born in the 18th century. Indeed the quantitatively most important type of lipids, the triglycerides, were the first class of natural products to be structurally clarified during the first half of the 19th century. Since then—at long intervals—other lipids too underwent structural analysis but interest in them was overshadowed by that in alkaloids and colouring matters from an inexhaustible variety of plants.

The reason for this development was the relative ease of separating a few alkaloids or dyes present in any given source compared with the still unsolved problem of performing a complete separation of lipids which may consist of hundreds of closely similar species. Fractionation into certain sub-classes can be effected and is being improved all the time but the fractions thus obtained may still contain, say, 50 species the further resolution of which requires equipment and manpower on the scale that only war space flight and sociological discourse appear to warrant. This being so, the isolation of a still heterogeneous lipid fraction does not give the same satisfaction as that of a pure compound. This militates against the recruitment of young graduates at the time they select their first research project.

The first branch of lipid chemistry to overcome this problem was that concerned with sterols. Cholesterol, from gall stones, has been purified and recognised as a (relatively) pure compound towards the middle of the 18th century but the elucidation of its structure took nearly 200 years. Meanwhile, however, other sterols were isolated and purified. During the last 50 years thousands of sterols and derivatives were isolated from natural sources; these included vitamins D, sex hormones, cortisone and related substances and these discoveries culminating in the mass-production of "the pill" earned fortunes for discoverers and manufacturers. The glamorous chemistry of sterols receives more attention in chemistry curricula than the study of all other lipids put together; considering the chairs held and Nobel prizes obtained by sterol chemists the bias is understandable.

Admittedly there are also purely theoretical reasons that make sterols interesting academic topics and virtually remove them from the projects of all but a few lipidologists. Substances of this nature furnish excellent examples of syntheses, reaction mechanisms and

arrangements in space. Work in this field revitalised alicyclic chemistry which would have lost interest had it been forced to rely entirely on its association with essential oils.

The detailed study of the bulk of lipids on the other hand suffered from the neglect of aliphatic (i.e. not cyclic) organic compounds which did not arouse much interest at a time when lack of methods for deeper structural studies made people assume that they knew all there was to be known about such structures. Modern instrumental techniques have changed this attitude, and in our days aliphatic compounds present a challenge to chemists whether they are interested in synthesis, structural studies, spatial chemistry, reactivity and so forth. The study of lipids benefited from this changed attitude but neither curricula nor government subsidies reflect this growing interest as yet.

A dramatic change may occur in the near future. Since much of the world's petroleum is in the hands of blackmailers who lack the technical knowledge required to find, drill, store, transport or process this commodity needed by advanced nations, and since the finding of alternative oil wells (possibly in equally unstable countries) may take time beyond what the industrial nations can afford, research into alternative fuels must be intensified. German methods of converting coal to oil are known and can be revived and improved, but more interesting is the problem of speeding up the processes that once converted living matter into petroleum.

Fermentation that provided Britain with acetone and butanol during the First World War contributed to the eventual creation of Israel. The present world situation is another challenge to a new Weizmann to find methods for the conversion of readily grown and harvested animal or plant lipids into petroleum. Michael Faraday distilled fat under pressure to produce a petroleum-like product. A more sophisticated procedure should not be beyond the powers of modern research. Almost certainly, such a solution would have strong biological and chemical elements. Inasmuch as it involved the establishment of a novel cyclic pattern of reactions, experts in non-linear thermodynamics and computer analysis would have to make their contributions.

Since lipids are closely associated with living processes, they serve as diagnostic indicators; accordingly they are involved in a substantial fraction of analyses carried out in clinical laboratories. All clinical assays will stray from absolute accuracy and precision, but some methods and some analyses are less reliable than others. In the absence of training in and sense for understanding scientific data and assessing their validity, results obtained by the analyst or the mechanised analyser can lead to foolish and dangerous

inferences. In the past medical training seldom included a study of scientific method, the "ancillary sciences" were taught to less than first degree levels and few doctors understood statistical methods. Conversely, students trained as clinical analysts are left insufficiently armed against contacts with a frequently arrogant profession.

The resulting flood of nonsense perpetrated in the name of "medical science" is most noticeable in the field of clinical lipid assays. E.g. cholesterol determinations show up not only cholesterol but also a number of similar substances. Consequently it is possible to choose methods to give high or low cholesterol values on the same serum, depending whether one wants to scare or reassure the patient.

Since few doctors know how to interpret chemical data and few of their tame chemists know or are confident enough to insist on the clinical significance of properly interpreted chemistry, simplistic "theories" on the dangers of cholesterol and magical merits of polyunsaturated fats abound to the detriment of public health and cause unwarranted damage to primary industries. Scientific progress also suffers when amateur claims are elevated to the status of dogma by princes of our feudal scientific community with the result that novel and fundamental studies are lucky to attract a small fraction of the sums spent on exercises in "epidemiology" (= statistical justification of poor analytical methods seen fit to support a strongly held prejudice).

There is no easy way to assess damage to health, agriculture and scientific progress in common terms but it is beyond doubt that a practical remedy would be cheaper. In our universities, and in the Colleges of Advanced Education that copy their mistakes, courses are too narrowly compartmentalised. Regional and national cliques that effectively control academic appointment and promotion favour the narrow specialist and detest the versatile, for the former is easier to shut up by specialists from the Big Brothers' League. A few more highly placed academics who are not idiots outside their sub-sub-speciality would go far to rectify evils of the present self-perpetuating and expanding academic fascism here and abroad.

A lipid chemist should be a good organic chemist with sophisticated knowledge of some branches of physics and physical chemistry, he should have a sound knowledge of biology, especially in the fields of biochemistry and pathology; he would also require competence in mathematics and an adult interest in philosophical matters bearing on scientific method.

One need not be an expert in any of these fields to realise that

a productive scientist of such qualifications would have difficulties with editors and referees of specialised journals. It is also clear that even if such obstacles were overcome he would be beaten for appointment, promotion and grants by diligent turners of the research equivalents of Tibetan prayer wheels.

Not surprisingly, lipid chemists are rarely found in leading academic positions. Industry, which, unlike universities, favours the versatile, offers better chances in a material sense but often in exchange for a greater freedom of enquiry.

The problem of lipid research can be summed up in the words of my late teacher, H. E. Fierz-David, an outstanding industrial chemist and a man of extreme-right Germanic views: "It is noteworthy how lipid research attracts the Jews." This oblique comment deserves to be quoted for the benefit of sophisticated readers at the risk that universities which continue to tolerate lipid chemists or improve their training in this age of oil jars occupied by Ali Baba's robbers will have to replace their Vice-Chancellor's car with a gig.

### THE BOUNDARY BETWEEN LANGUAGES AND THE SOCIAL SCIENCES

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ONE of the least talked about, yet probably the most ill-conceived and costly of all of the boundaries between disciplines, is that which has come to exist between languages and all other disciplines, but particularly the social sciences.

Unlike the other boundaries between other disciplines, this is not a traditional one, nor is it found outside Australia. It is in fact a fairly recent development, and it is in some universities being enforced with increasing rigour. In 1964, there were only 139 students from faculties other than Arts who were studying a language at a university throughout the whole of Australia.<sup>1</sup> In the years since that survey was taken, this number has not significantly grown. Languages departments in Australian universities are almost invariably "literature" departments whose principal interest is in the field of aesthetic and literary analysis. The common experience of foreign language students is such that they rarely have significant training in any other disciplines besides languages, and similarly, students of other disciplines rarely can

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